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Assessment of Industrial Hazardous Waste Practices, Rubber and Plastics Industry Executive Summary

Foster D. Snell, Inc., Florham Park, N.J.

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ASSESSMENT OF INDUSTRIAL HAZARDOUS WASTE PRACTICES,

RUBBER AND PLASTICS INDUSTRY

Executive Summary

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U.S. ENVIRONMENTAL PROTECTION AGENCY

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16. ABSTRACT

This industry study is one of a series under the Office of Solid Waste Management Program of the Hazardous Waste Management Division, U.S. Environmental Protection Agency. The report concentrates on the rubber and plastics industry. It characterizes these industries in terms of number, location, size and age of plants, products, processes, etc.; identifies and quantifies those wastes which are or may be generated by these industries; describes current practices for treatment and disposal of potentially hazardous wastes; determines the control technologies which might be applied to reduce hazards presented by these wastes upon disposal; and estimates the cost of control technology implementations.

The information presented in the report was acquired from a review of published information; trade association participation; personal contacts; visits to various plants and corporate offices of germane companies; waste sample analysis; and the application of an econometric model to project waste loads for 1977 and 1983.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Control Costs Hazardous Wastes Industrial Wastes Plastics Industry Residues Rubber Industry Sludges Solid Wastes Waste Generation Factors	Chemical Treatment Hazard Potential Incineration Land Filling Lagooning Resin Manufacture Stream Separation Toxicity	

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Appreciation is extended to the following trade associations for assistance and cooperation in this program:

- Rubber Manufacturers Association
- International Institute of Synthetic Rubber Producers
- Manufacturing Chemists Association
- Textile Economics Bureau
- Society of the Plastics Industry

Appreciation is also extended to the many rubber products manufacturers, plastic resin, synthetic rubber and fiber producing companies, who cannot be mentioned by name due to reasons of confidentiality, without whose assistance this report could not have been written.

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I. EXECUTIVE SUMMARY -- ASSESSMENT OF INDUSTRIAL HAZARDOUS WASTE PRACTICES, RUBBER AND PLASTICS INDUSTRY

This chapter introduces the study, describes how the report is organized and provides a summary of the major findings and conclusions.

1. INTRODUCTION

This industry study is one of a series by the Office of Solid Waste Management Programs, Hazardous Waste Management Division. The studies were conducted for information purposes only and not in response to a Congressional regulatory mandate. As such, the studies serve to provide EPA with: (1) an initial data base concerning current and projected types and quantities of industrial wastes and applicable disposal methods and costs; (2) a data base for technical assistance activities; and (3) a background for guidelines development work.

The definition of "potentially hazardous waste" in this study was developed based upon contractor investigations and professional judgment. This definition does not necessarily reflect EPA thinking since such a definition, especially in a regulatory context, must be broadly applicable to widely differing types of waste streams. Obviously, the presence of a toxic substance should not be a major determinant of hazardousness if there were mechanisms to represent or illustrate actual effects of wastes in specified environments. Thus, the reader is cautioned that the data presented in this report constitute only the contractor's assessment of the hazardous waste management problem in these industries.

Foster D. Snell, Inc., a subsidiary of Booz·Allen & Hamilton Inc., began this program for the Environmental Protection Agency (EPA), Office of Solid Waste Management Programs (OSWMP), on May 28, 1975. It covers Standard Industrial Classifications (SIC) 282, the plastic materials and synthetics industry and SIC 30, rubber products industry (exclusive of SIC 3079, miscellaneous plastic products).

The basic objectives of this study are to:

- Characterize the industry in terms of number, location, size and age of plants, products, processes, etc.
- Identify and quantify those total and potentially hazardous wastes which are or may be generated by the rubber and plastic industry.

- Describe current practices for treatment and disposal of potentially hazardous wastes.

- Determine the control technologies which might be applied to reduce hazards presented by these wastes upon disposal.

- Estimate the cost of control technology implementation.

This report is organized into three chapters:

- Chapter I -- EXECUTIVE SUMMARY

- Chapter II -- PLASTICS MATERIALS AND SYNTHETICS INDUSTRY, SIC 282

- Chapter III -- RUBBER PRODUCTS INDUSTRY, SIC 30

The industrial hazardous waste practices were assessed separately for the rubber and plastics industry segments of the report. This assessment was performed in four phases of effort.

- Phase I -- Industry Characterization.
  A characterization of the industry with regard to the number, location, size and production of manufacturing establishments

- Phase II -- Waste Characterization.
  Identified and quantified those total and potentially hazardous wastes which are or will be generated by the rubber and plastics industry

- Phase III -- Treatment And Disposal Technology.
  Described current practices for treatment and disposal of total and potentially hazardous wastes and determined control technologies which might be applied to reduce potential hazards presented by these wastes upon disposal

- Phase IV -- Cost Analysis.
  Estimated the cost of control technology implementation, and compared this cost with an appropriate business indicator.

The individual elements of each of these phases are presented in detail in their respective sections of this report.

2. SYNOPSIS OF PROGRAM METHODOLOGY

There were three major steps taken by the study team in preparing the report: data acquisition, data analysis and the development of the criteria for the determination of which wastes which should be considered potentially hazardous. Figure I-1 summarizes the program logic. Appendix A, at the end of the report, details the program methodology.

2.1 Data Acquisition

The data required for this study were obtained from five sources:

- Review of published information and data in:
  - technical literature
  - trade journals
  - government reports
  - technical and economic surveys conducted by industry associations

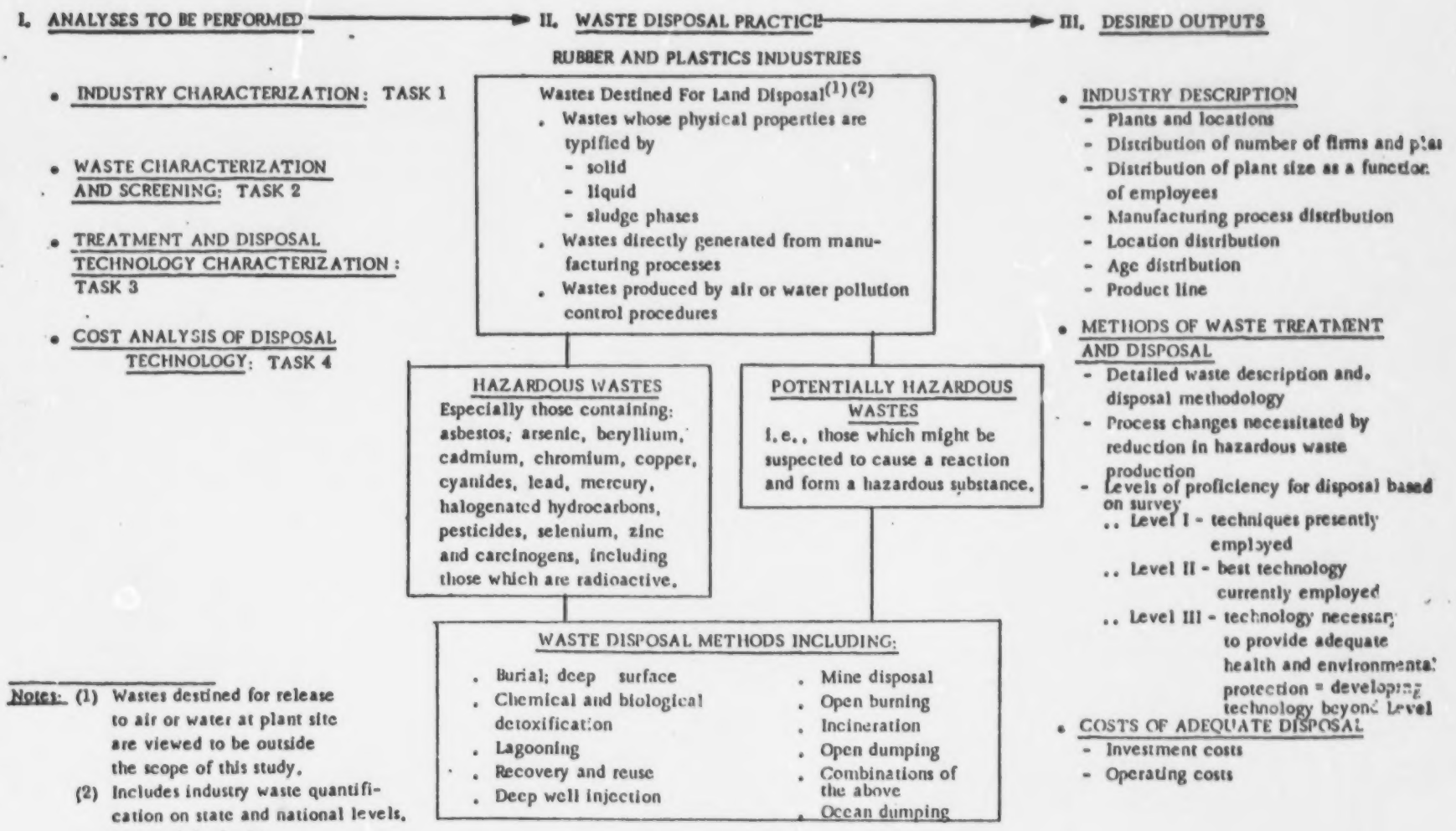
  Some of these references are cited throughout this report.

- Utilization of data collected during our previous work in these industries, which included:
  - A study of hazardous waste materials, hazardous effects and disposal methods for EPA
  - An industrial energy study of the plastics and rubber industries for the Federal Energy Administration

- Trade association participation, including:
  - Rubber Manufacturers Association
  - International Institute of Synthetic Rubber Producers
  - Manufacturing Chemists Association
  - Textile Economics Bureau
  - Society of the Plastics Industry

FIGURE I-1

STUDY LOGIC


I. ANALYSES TO BE PERFORMED
II. WASTE DISPOSAL PRACTICE
III. DESIRED OUTPUTS
• INDUSTRY CHARACTERIZATION: TASK 1
• WASTE CHARACTERIZATION AND SCREENING: TASK 2
• TREATMENT AND DISPOSAL TECHNOLOGY CHARACTERIZATION: TASK 3
• COST ANALYSIS OF DISPOSAL TECHNOLOGY: TASK 4
RUBBER AND PLASTICS INDUSTRIES
Wastes Destined For Land Disposal(1)(2)
. Wastes whose physical properties are typified by
- solid
- liquid
- sludge phases
. Wastes directly generated from manufacturing processes
. Wastes produced by air or water pollution control procedures
HAZARDOUS WASTES
Especially those containing: asbestos, arsenic, beryllium, cadmium, chromium, copper, cyanides, lead, mercury, halogenated hydrocarbons, pesticides, selenium, zinc and carcinogens, including those which are radioactive.
POTENTIALLY HAZARDOUS WASTES
I.e., those which might be suspected to cause a reaction and form a hazardous substance.
WASTE DISPOSAL METHODS INCLUDING:
. Burial; deep surface
. Chemical and biological detoxification
. Lagooning
. Recovery and reuse
. Deep well injection
. Mine disposal
. Open burning
. Incineration
. Open dumping
. Combinations of the above
. Ocean dumping
• INDUSTRY DESCRIPTION
- Plants and locations
- Distribution of number of firms and plan
- Distribution of plant size as a function of employees
- Manufacturing process distribution
- Location distribution
- Age distribution
- Product line
• METHODS OF WASTE TREATMENT AND DISPOSAL
- Detailed waste description and disposal methodology
- Process changes necessitated by reduction in hazardous waste production
- Levels of proficiency for disposal based on survey
.. Level I - techniques presently employed
.. Level II - best technology currently employed
.. Level III - technology necessary to provide adequate health and environmental protection = developing technology beyond Level
• COSTS OF ADEQUATE DISPOSAL
- Investment costs
- Operating costs

Notes: (1) Wastes destined for release to air or water at plant site are viewed to be outside the scope of this study.

(2) Includes industry waste quantification on state and national levels. (wet and dry basis)

Source: Snell review and analysis of study requirements.

Data acquisition by personal contacts and visits to the various plants and corporate offices of companies classified in this industry and to waste disposal firms handling potentially hazardous wastes. During the course of this study, a total of 88 field trips were made as follows:

- Visits to 64 production units in SIC 282 and 30
  - .. Nineteen in SIC 2821
  - .. Thirteen in SIC 2822
  - .. Two in SIC 2823
  - .. Seven in SIC 2824
  - .. Eight in SIC 3011
  - .. One in SIC 3031
  - .. Four in SIC 3041
  - .. Ten in SIC 3069
- Visits to 10 waste disposal facilities
  - .. Five in SIC 282
  - .. Five in SIC 30
- Nine visits to industry associations
- Five visits to government agencies

In addition, 39 waste samples were analyzed in our laboratories

- Twenty-one samples from SIC 282
- Eighteen samples from SIC 30

A detailed description of the analytical procedures used and the results obtained are in Appendix B. Due to the numerous products and processes used in the industries studied, the sampling program could not obtain a statistically valid overview of waste stream compositions. Instead, results were used as a guide in validating assumptions made regarding potentially hazardous constituents in the waste streams studied.

- Estimates of industry growth in order to project waste loads for the years 1977 and 1983 were based on the use of the Interindustry Economic Research Project of the University of Maryland (INFORUM) input/output model of the U.S. economy, information obtained from the sources listed above and Snell estimates. The INFORUM model is described in Appendix A.

2.2 Data Analysis

Data analysis involved the following major tasks:

- Review of collected information for reliability
- Assembly of a data base composed of the reliable information so that estimates and projections can be made
- Tabulations of the wastes on a state, EPA region and national basis from estimates and projections made possible by the data assembly task

The excellent cooperation of the Rubber Manufacturers Association and its members provided such in-depth information that the data base, potentially hazardous waste aggregations and treatment and disposal technology cost estimates for the Rubber Products Industry, SIC 30, are generally the most accurate of the two major groups studied. These are estimated to have an accuracy of $\pm$ 20 percent. The accuracy of data reported for SIC 282, Plastic Materials and Synthetics Industry, vary with the product manufactured.

- In those cases where raw plant data was obtained, accuracy is estimated to be as good as $\pm$ 20 percent. The situation was found for SIC 2822 in general and the major products of the other segments
- For products such as phenolics, alkyds and epoxy resins, engineering estimates had to be made due to the many and varied plants and processes used to produce these resins. These estimates may have an accuracy of $\pm$ 50 percent and should be considered to be illustrative in nature

At times engineering estimates were made due to lack of cooperation or data being withheld to avoid disclosure of confidential information. The accuracy of this data could be considerably less. Where the data is of questionable validity, it is so noted within the report.

2.3 Criteria For Determining Which Wastes Should Be Considered Potentially Hazardous

A detailed discussion of these criteria is presented in Appendix A, which describes the methodology used for this study. Essentially, the methodology involved an examination of the types of wastes generated on a case by case basis utilizing published information, engineering and scientific judgment by the study team and spot checks of wastes obtained during the sampling program.

2.3.1 Classification Of A Waste

For the purposes of this study, a waste is classified as:

- Land destined wastes whose physical properties can be categorized as:
  - Solid
  - Liquid
  - Sludge (semi-solid)
- Wastes directly generated from manufacturing processes and not disposed of as part of the plant water and air effluents
- Wastes produced by air or water pollution control processes

By-products which are sold are not considered to be wastes within the context of the study, unless there is a significant likelihood that these will become wastes in the future due to changing economic conditions.

2.3.2 Definition Of A Potentially Hazardous Waste

A potentially hazardous waste refers to any waste or combination of wastes which pose a substantial present or potential hazard to human health or living organisms because such wastes may be suspected of being:

- Toxic (including carcinogenic)

- Flammable or explosive
- Corrosive or reactive
- Biologically magnified or persistent

These types of hazards represent four out of the five basic hazardous characteristics of wastes which were established in Report to Congress -- Disposal of Hazardous Wastes, Office of Solid Waste Management Programs (SW-115), U.S. Environmental Protection Agency, 1974. The fifth characteristic, radioactivity, does not apply to the wastes generated in the industries under study.

2.3.3 Criteria For Determining Potential Hazard

The two industries studied -- plastics (SIC 282) and rubber (SIC 30) use different processes in the manufacture of their products. SIC 282 industries are manufacturers of polymers, while SIC 30 fabricates finished products using many of the materials produced by SIC 282. Due to the differences in processes between these two groups, there is a great dissimilarity in the waste types produced.

Wastes produced by SIC 30 are similar in the physical and chemical properties and generally consist of the materials used in manufacturing their products either in a free state or entrapped in a cured or uncured rubber matrix.

Wastes produced by SIC 282, on the other hand, are of a variety of types including:

- Off-grade products
- Still bottoms
- Spent adsorbents and filters
- Spent catalysts
- Waste oils
- Waste water treatment sludges

However, the same criteria were applied in deciding on the potential hazard of the wastes generated by the two industries. This was done because a very conservative approach was used in developing the criteria.

Wastes identified by unit operation were examined on a case by case basis to identify its constituents. The constituents were identified from the results of industry interviews, published literature, scientific and engineering judgment of the study team and the results of the analysis of waste samples obtained from industry.

Detailed original toxicological, chemical and biological investigations to determine the potential for hazard creation of the literally thousands of chemical substances in those industries which may become wastes was not to be a requirement according to the mandate given by Foster D. Snell, Inc. by EPA. Therefore, published sources which are compendia of information on criteria for hazards classification were used.

The published sources were searched for the wastes' constituents. The waste was then classified as potentially hazardous if it contained constituents in the unbound state, which are, according to the reference(1).

. Toxic to Humans

- Very highly toxic causing death or residual injuries to persons exposed to relatively low concentrations or has potential to be carcinogenic

- Those substances where short intense exposures or continued exposures at lower concentration levels may cause serious temporary or minor residual injury

- Those substances whose toxicity has not as yet been determined

(1) See Appendix A for reference.

. Flammable, Explosive, Corrosive or Reactive

- Readily capable of detonation and explosive decomposition or reaction at normal ambient temperatures and pressures. Will detonate as result of mechanical shock or local thermal shock. Reacts readily with own oxides or with oxidizing materials. Can ignite spontaneously and/or react violently if exposed to moisture in soil. Ignition or reaction can product lethal vapors, fumes, etc.

- Those substances which can readily undergo violent chemical change with rapid release of energy, but will not detonate explosively or react violently, except under very special circumstances such as heating under confinement. Can ignite and burn rapidly to produce harmful, though not lethal, vapors and fumes if exposed to modest increase of temperature or if moisture is encountered.

- Those substances with unknown properties.

. Biologically Magnified or Persistent or Otherwise Ecologically Destructive

- Highly lethal on contact to most vegetation and/or earth organisms. May be soluble in water and can flow with surface or ground waters to affect vegetation and/or aquatic life in remote streams, ponds, lakes, etc. Potential hazard to public or private fresh water supplies because of persistence.

- On substances which are lethal on contact to only sensitive species of plants and/or earth organisms. General damage to vegetation and earth organisms may be substantial, but is reversible. May affect remote vegetation on aquatic life only under unusual circumstances of surface drainage or ground water penetration.

- Those substances with unknown properties.

3. SUMMARY OF THE STUDY

The industries studied in this project were as follows:

- Plastic Materials and Synthetics, SIC 282
  - Plastics Materials and Resins, SIC 2821
  - Synthetic Rubber, SIC 2822
  - Cellulosic Manmade Fibers, SIC 2823
  - Organic Fibers, Non-Cellulosic, SIC 2824
- Rubber Products Industry, SIC 30
  - Tires and Inner Tubes, SIC 3011
  - Rubber and Plastics Footwear, SIC 3021
  - Reclaimed Rubber, SIC 3031
  - Rubber and Plastics Hose and Belting, SIC 3041
  - Fabricated Rubber Products, N.E.C., SIC 3069

This section of the Executive Summary presents a synopsis of the major findings and conclusions and an analysis of key information developed on those industries. The plastics industry will be discussed first, followed by the rubber industry.

3.1 Summary Of The Plastics Materials And Synthetics Industry, SIC 282

This section briefly summarizes industry structure, manufacturing processes, total and potentially hazardous wastes generated, and treatment and disposal technologies and associated costs for potentially hazardous wastes identified for SIC 282. A detailed discussion of these topics is presented in Chapter II of this report.

3.1.1 Industry Characterization

This section presents the number of production units, total industry production and employment for those establishments classified in SIC 282 based on information developed by the study team. Note that a production unit is a facility making a particular resin within an SIC. These production units may be combined to form plants or plant complexes manufacturing a wide variety of products in one or many SICs.

- SIC 2821 has approximately 818 production units, a total production for 1974 in excess of 120,000 KKg (metric tons) and a total employment of about 56,000.

- SIC 2822 has approximately 120 production units, a total production for 1974 in excess of 40,000 KKg (metric tons) and employed about 17,000.

- SIC 2823 has about 13 production units still in operation, produced upwards of 5,380 KKg (metric tons) of product in 1974 and employed about 5,000.

- SIC 2824 has 153 production units in operation, produced over 136,000 KKg (metric tons) of product in 1974 and employed about 100,000.

Most of the plants in SIC 2821 and 2822 are located in the Gulf States such as Louisiana and Texas and California areas (EPA Regions VI and IX) near suppliers of their feed stocks. The majority of SIC 2823 and 2824 plants are located in the South Atlantic states such as Tennessee, North Caroline and South Carolina (EPA Regions III and IV) near the textile mills which consume their output.

An alphabetical listing of plants classified in SIC 282 is contained in EPA, OSWMP, Hazardous Waste Management Division files.

3.1.2 Waste Characterization

In general, the two major processes used in the plastic materials and synthetics industry:

- Polymerization, or the chemical linking together of simple building blocks (monomers) of recurring structural units to form long chain length molecules (polymers)

- Spinning, or the extrusion of polymers through spinnerets to form fibers.

Polymerization is used in all segments of SIC 282, except SIC 2823. Spinning is used in SIC 2823 and 2824.

3.1.2.1 Potentially Hazardous And Non-Hazardous Wastes

The six general waste streams associated with the processes used in SIC 282 are:

- Off-grade products
- Still bottoms
- Spent adsorbents and filters
- Spent catalysts
- Waste oils
- Waste water treatment sludges

Depending on the product manufactured, all, some or none of the wastes may be present and/or potentially hazardous.

3.1.2.2 Criteria For The Determination Of Which Wastes Should Be Considered Potentially Hazardous

Wastes classified as potentially hazardous may be generated from essentially all the unit operations carried out in SIC 282. These wastes are so classified because they are likely to:

- Contain known toxic or possibly carcinogenic materials, e.g., be contained in floor sweepings, sludges and still bottoms in an unbound and unreacted state

- Be composed of significant quantities of materials having low flash points and therefore be potentially flammable, e.g., still bottoms and bad batches.

3.1.2.3 Methodology Used In Sampling And Analyzing The Various Waste Streams

Sampling of waste streams was used to spot check the presence and concentration of suspected compounds. The information obtained from the sampling program was from selective samples and not samples from the total industry.

Samples were obtained of a wide variety of wastes from cooperating establishments in each of the SIC 282 industry segments under the supervision of Snell team members.

The tests performed on the samples, where required, were as follows:

- Water extraction -- designed to determine quantitatively the water soluble fraction of the sample

- Water content of liquid samples -- designed to aid in the calculation of the wet versus dry basis of waste loads to be disposed

- Flammability of liquid samples

- Ash residue -- provides a measure of the percent of total inorganic content of the sample

- Emission spectroscopy -- provides a semi-quantitative value for the concentrations of metals in the sample by type

- Atomic absorption spectroscopy -- performed selectively to provide quantitative values for the concentrations of particular metals identified by emission spectroscopy and those which cannot be, e.g., mercury, cadmium and lead

- Special tests -- these tests were performed on a selective basis on waste streams judged to contain special hazardous components. These tests included:

  - Residual vinyl chloride monomer determinations on wastes from plants producing polyvinyl chloride based polymers

  - Phenol determination on wastes from plants producing phenolic resins

  - Boron and fluoride determinations from waste streams generated by coumarone-indene resin plants

Detailed methodology and test results for the sampling program are discussed in Appendix B.

3.1.2.4 Identification Of Those Hazardous Constituents Found In Waste Streams

Potentially hazardous constituents found in SIC 282 waste streams and the criteria which caused it to be so classified include:

- Flammable proprietary waste solvents from silicone rubber production

- Aromatic and chlorinated hydrocarbons present in still bottoms from monomer or solvent recovery due to their flammability and possible carcinogenic properties

- Phenol and formaldehyde contained in sludges and partially polymerized material from phenolic resin production due to their toxicity

- Formaldehyde contained in bad batches (off-grade product) still bottoms and filter cake from amino resin production due to its toxicity

- Maleic acid contained in contaminated floor sweepings from alkyd production due to its toxicity

- Boron and fluoride contained in spent clays from coumarone-indene resin production due to its toxicity

- Significant concentrations of zinc salts contained in sludges from rayon and acrylic fiber wet spinning operations due to their toxicity

Wastes produced from the manufacture of polyvinyl chloride (PVC) resins are not considered to be potentially hazardous in the opinion of the study team. Waste samples obtained from manufacturers showed vinyl chloride monomer concentrations in the wastes of less than 10 ppm. Companies manufacturing the polymers have improved and are improving stripping technology significantly to reduce this level further. The residual vinyl chloride monomer is entrapped in the PVC matrix and has a low probability of escape into the environment.

Recently, it has been reported that deaths have occurred of workers involved in styrene production attributable to leukemia. Investigations by Government Agencies are now being carried out to determine the connection between employment of a styrene plant and mortality due to leukemia. Since the results of the investigation are not yet available, wastes produced from processes involving styrene are not considered to be potentially hazardous. However, if in the future, the cause of leukemia is attributed to styrene, it will be possible to estimate the quantity of the potentially hazardous fraction of the waste produced by plants using styrene from information contained in this report.

Over the past few months Snell has learned from personel in the Technical Assistance Program of EPA, HWMD that Kevlar, an organic fiber manufactured by duPont at their Richmond, Virginia plant contains HMPA, hexamethylphosphoric triamide. HMPA is a suspect carcinogen and is reported by EPA personnel to be present in the fiber at a concentration of between 20 to 30 ppm. Since this information was obtained by our organization well after the data collection phase of this project was completed, a detailed investigation by Snell was not undertaken. If the allegations are true, an investigation of wastes produced during Kevlar manufacture should be undertaken.

3.1.2.5 Waste Quantification For 1974, 1977 And 1983

Wastes for the industry in 1974 were estimated by multiplying the total and potentially hazardous waste factors for each of the products manufactured by the production values for the product.

For 1977 and 1983, the basic factors influencing the evaluation of solid waste volumes are:

- Production volume changes
- The effects of more stringent requirements of water pollution control

The waste loads for 1977 are only expected to vary with changes in production output. The effect of the 1977 Water Effluent Guidelines Regulations is not expected to be significant due to the fact that most of the plant personnel interviewed indicated that technology necessary to meet the 1977 requirements was already in place. Thus, the waste factors developed in this study already account for this technology.

For 1983, the cumulative effect of uncertainties in changes of production volumes and water pollution control regulations is such that the only feasible approach to making the waste projections in terms of sound engineering judgement was to discount elements other than production growth.

Estimates of production for the years 1977 and 1980 were obtained from the Interindustry Economic Research Project of the University of Maryland (INFORUM) input/output model of the U.S. economy.

Table I-1 presents the waste quantifications for the years of interest as a summary for the entire SIC 282. The waste quantities are presented on both a dry and wet basis.

From the table it can be seen that total and potentially hazardous waste loads on a dry and wet basis for the country as a whole are as follows:

	Total Wastes		Potentially Hazardous Wastes	
	Wet (KKg/Yr)	Dry (KKg/Yr)	Wet (KKg/Yr)	Dry (KKg/Yr)
1974	2,751,319	1,504,469	740,351	157,347
1977	3,329,095	1,820,407	895,824	190,389
1983	4,294,533	2,348,326	1,155,614	245,602

Source: Foster D. Snell, Inc.

TABLE I-1

GEOGRAPHIC DISTRIBUTION OF WASTES
FOR THE PLASTICS INDUSTRY, SIC 282
(KKg/Yr.)

	Wet Basis						Dry Basis					
	1974		1977		1983		1974		1977		1983	
Region	Total	Potentially Hazardous	Total	Potentially Hazardous	Total	Potentially Hazardous	Total	Potentially Hazardous	Total	Potentially Hazardous	Total	Potentially Hazardous
I	100,287	29,857	121,347	36,127	156,538	46,604	57,966	8,606	70,139	10,413	90,479	13,433
II	215,097	101,898	260,267	123,296	335,745	159,052	92,307	13,414	111,691	16,231	144,082	20,938
III	393,602	88,696	476,258	107,322	614,373	138,446	242,427	20,141	293,337	24,371	378,404	31,438
IV	1,185,274	181,940	1,434,182	220,147	1,850,094	283,990	661,614	33,377	800,553	40,386	1,032,713	52,098
V	348,462	123,746	421,639	149,733	543,914	193,155	152,093	25,010	184,032	30,262	237,402	39,038
VI	385,425	126,824	466,364	153,457	601,610	197,960	256,877	42,732	310,821	57,706	400,950	66,700
VII	11,312	8,670	13,688	10,491	17,657	13,533	4,214	1,575	5,099	1,906	6,578	2,459
VIII	1,310	1,310	1,585	1,585	2,045	2,045	183	182	211	220	286	284
IX	71,667	39,700	86,717	48,037	111,865	61,968	30,923	7,498	37,417	9,072	48,268	11,703
X	38,883	37,710	47,048	45,629	60,692	58,861	5,865	4,812	7,097	5,822	9,155	7,511
Total:	2,751,319	740,351	3,329,095	895,824	4,294,533	1,155,614	1,504,469	157,347	1,820,407	190,389	2,348,326	245,602

Source: Foster D. Snell, Inc.

Figure I- 2 , pictorially presents the estimated geographic distribution of total wastes (dry basis). Figure I- 3 , does the same for potentially hazardous wastes (dry basis) for the year 1974. The estimated geographic distribution of wastes will not change for 1977 and 1983 in relation to 1974.

Generally, the greatest total and potentially hazardous waste loads (dry basis) are distributed among the states in EPA Regions IV, VI and III reflecting the heavy concentration of SIC 282 establishments in the Gulf and South Atlantic states.

- In terms of total wastes (dry basis), EPA Region IV has the greatest quantity of wastes to be disposed of

- In terms of potentially hazardous wastes (dry basis), EPA Region VI is first

Tables in Chapter II break out total and potentially hazardous wastes generated by manufacture of SIC 282 products. The largest contribution to potentially hazardous wastes include:

- Flammable and possibly carcinogenic still bottoms from styrene based polymer production (SIC 2821 and 2822)

- Toxic off-grade products, still bottoms and wastewater treatment sludges from phenolic and amino resin production (SIC 2821 and 2822)

- Toxic zinc containing wastewater treatment sludges from acrylic spinning operations (SIC 2824)

The largest single contributor is phenolics with an estimated 366,000 KKG (wet weight) in 1974 of an aqueous solution of phenol and formaldehyde as the potentially hazardous constituents.

FIGURE I-2

GEOGRAPHIC DISTRIBUTION OF TOTAL WASTES,
PLASTICS INDUSTRY, SIC 282 (DRY BASIS)
(KKg/Yr) (1974)

Source: Foster D. Snell, Inc.

FIGURE I-3

GEOGRAPHIC DISTRIBUTION OF POTENTIALLY HAZARDOUS WASTES, PLASTICS INDUSTRY, SIC 282 (DRY BASIS) (KKg/Yr) (1974)

Source: Foster D. Snell, Inc.

3.1.3 Treatment And Disposal Technology

This section briefly reviews the various treatment and disposal technologies practiced by the plastic materials and synthetics industry and identifies the three levels for those waste streams considered potentially hazardous.

3.1.3.1 Present Potentially Hazardous Waste Treatment And Disposal Practices

The treatment and disposal methods presently practiced in this industry are:

- Incineration
- Landfill
- Lagooning
- Storage

Note that contract disposal ultimately results in the use of one or more of these methods.

Incineration is used to dispose of waste streams usually containing significant amounts of organics. It is universally practiced in SIC 282 industries, especially for the disposal of still bottoms.

Landfilling represents the other major disposal technology used in this industry for those wastes classified as potentially hazardous. These wastes are usually waste water treatment sludges contaminated with metal ions. This method is employed, for example, for sludges emanating from rayon and acrylic fiber production.

Lagooning is sometimes used as an alternate to landfilling. Lagooning is more land intensive than landfilling because a substantial amount of water is stored with the sludge. Ultimately, the settled sludge in a lagoon usually is transferred to landfill. In effect, lagooning is more a form of storage than disposal. Lagooning has been used for the sludges from rayon spinning operations.

Storage in metal drums or concrete pits, as practiced in some phenolic resin plants, can only be a temporary measure pending development or installation of adequate treatment and disposal technology.

3.1.3.2 Identification Of The Levels Of Treatment And Disposal Technology For Those Streams Considered To Be Potentially Hazardous

The levels of treatment and disposal technology are characterized as follows:

- Level I -- Technology Currently Employed By Typical Facilities
- Level II -- Best Technology Currently Employed
- Level III -- Technology Necessary To Provide Adequate Health And Environment Protection

These levels were evaluated for the potentially hazardous wastes generated by SIC 282 by the use of ten factors:

- I -- Physical and Chemical Properties of the Waste
- II -- Amount of Waste
- III -- Factors Affecting Hazardousness of the Waste
- IV -- Adequacy of Technology
- V -- Non-Land Environmental Impact
- VI -- Problem Areas or Comments
- VII -- Compatibility With Existing Facilities
- VIII -- Monitoring and Surveillance Techniques
- IX -- Installation Time For New Facility
- X -- Energy Requirements

Levels of treatment and disposal technology are described for important potentially hazardous wastes in a series of tables in Chapter II. These wastes are:

- Liquid Phenolic Wastes, SIC 2821
- Solid/Semisolid Phenolic Wastes, SIC 2821
- Still Bottoms (Aromatic, Aliphatic, Chlorinated, etc.), SIC 282

- Off-Grade Product in Amino Resin Production, SIC 2821

- Zinc Oxide Sludges From Waste Water Treatment in Cellulosic and Acrylic Fiber Production, SICs 2823 and 2824

The data indicates that in most cases potentially hazardous wastes are being disposed in an environmentally adequate fashion as shown in Table I-2 . For those cases where improvement is needed (phenolics), technology is under development.

3.1.4 Cost Analysis For The Treatment And Disposal Of Potentially Hazardous Wastes, Plastic Materials And Synthetics Industry

The analyses performed are of an illustrative nature and not necessarily true costs for the entire industry. The existence of well defined, self contained production facilities for most of the products of this industry are exceptions to the rule. These facilities are shared at most locations with those required to handle the wastes of other products. These "co-products" may belong to SIC 282 or in entirely different classifications.

The estimates presented were prepared on an engineering basis, using accepted engineering format. No attempt was made to prepare estimates which would reflect impact on individual companies' financial statements. Inclusion of tax considerations, product pricing and other such factors would entail practices unique to each company and should be recognized as beyond the scope of this report.

3.1.4.1 Case Studies Of Potentially Hazardous Waste Treatment And Disposal Costs

Based on the considerations outlined above, the individual costs for typical plants in SIC 282 have been calculated. The results of these calculations are presented in nine tables in Chapter II.

TABLE I-2

SUMMARY OF THREE LEVELS OF TREATMENT AND DISPOSAL TECHNOLOGY FOR SIC 282

	Waste	SIC Code	Level I	Level II	Level III
1.	Liquid Phenolic Wastes	2821	Incineration/Storage (metal drums or concrete pits)	Incineration	Same as Level II
2.	Solid/Semisolid Phenolic Waste	2821	Storage (metal drums or concrete pits)	Same as Level I	None identified
3.	Still Bottoms (Aromatics, Aliphatics, Chlorinated, etc.)	282	Incineration with necessary air pollution control	Same as Level I	Same as Level I
4.	Off-Grade Product and Bad Batches From Amino Resin Production	2821	Material is placed in steel drums at plant and then incinerated by contractor off-site with necessary air pollution control	Same as Level I	Same as Level I
5.	Waste Catalyst from Polyester Production	2821 and 2824	Storage in steel drums	Same as Level I	None identified
6.	Zinc Oxide Sludge From Waste Water Treatment in Cellulosic and Acrylic Fiber Production	2823 and 2824	Secured Landfill	Recovery	Same as Level II

Source: Foster D. Snell, Inc.

Detailed costs are not provided for the treatment and disposal of solid and liquid potentially hazardous wastes from amino resin production because these costs would be insignificant and production techniques are so varied that even illustrative examples would not be valid.

3.1.4.2 Extrapolation Of Technology Costs To The Entire Plastic Materials And Synthetics Industry, SIC 282

Yearly expenditures for potentially hazardous waste treatment and disposal are presented in Table I-3. These costs may be summarized as follows:

	Million Dollars (1974)			
T/D Level[1]	I	II	III	
Technology			1	2
SIC 282	13.33	4.37[2]	14.33	4.37[2]

(1) Assumes that each production facility is operating at their respective levels of full production.

(2) The total reflects the net profit from zinc recovery in rayon and acrylic fiber production.

Source: Foster D. Snell, Inc.

The totals presented above are purely illustrative. They would be substantially affected by shifts in the relative importance of the various products manufactured in each segment of the industry.

3.1.4.3 Comparison Of Technology Costs With Production Value For The Entire Plastic Materials And Synthetics Industry

Table I-4 presents the percent of production value allocated to treatment and disposal of potentially hazardous wastes. These relationships are summarized as follows for SIC 282.

TABLE I-3

YEARLY EXPENDITURES FOR POTENTIALLY HAZARDOUS WASTE DISPOSAL IN THE MAJOR SEGMENTS OF THE PLASTIC MATERIALS AND SYNTHETICS INDUSTRY BY T/D LEVEL -- SIC 282

SIC Code	Product	Production (KKKg/yr.)	Wastes (KKg/yr.)	T/D Level / Technology	I 1	II 1	III 1	III 2
					($ Million, 1974)			
2821	Phenolics[1]	610	361,000		10.50	11.50	11.50	N.A.
2822	Styrene Butadiene Rubber	2,116	12,700		.46	.46	.46	N.A.
2821	Polystyrene	1,844	18,440		.56	.56	.56	N.A.
2821	ABS-SAN	440	2,200		.06	.06	.06	N.A.
2821	Polypropylene	1,026	10,260		.23	.23	.23	N.A.
2824		1,170	11,700		.26	.26	.26	N.A.
2823	Rayon	360	36,000		.03	(2.10)[2]	.03	(2.10)[2]
2824	Acrylics/Modacrylics	1,390[3]	278,000		1.23	(6.60)[2]	1.23	(6.60)[2]
2821	Subtotals				11.35	12.35	12.35	12.35
2822					.46	.46	.46	.46
2823					.03	(2.10)[2]	.03	(2.10)[2]
2824					1.23	(6.60)[2]	1.23	(6.60)[2]
282	Total				13.33	4.37[4]	14.33	4.37[5]

Note: For technology definitions see individual cost tables.

(1) This represents a summation of two waste streams: liquid and solid.

(2) Net profit from zinc recovery.

(3) The wastes originate in spinnning operations only.

(4) The total reflects the net profit from zinc recovery in rayon and acrylics. Recovery is assumed at all production sites.

(5) The total includes costs of Level I technologies for those products which do not have Level III-2 technologies.

N.A. = Not Applicable.

Source: Foster D. Snell Inc.

Table I-4

PERCENT OF PRODUCTION VALUE ALLOCATED TO TREATMENT AND DISPOSAL OF POTENTIALLY HAZARDOUS WASTE IN THE PLASTIC MATERIALS AND SYNTHETICS INDUSTRY--SIC 282

SIC Code	T/D Level / Technology	Percent Of Production Value			
		I	II	III 1	III 2
2821		0.25	0.28	0.28	0.28
2822		0.042	0.042	0.042	0.042
2823		0.0048	(0.33) (1)	0.0048	(0.33) (1)
2824		0.034	(0.18) (1)	0.034	(0.18) (1)
Total		0.14	0.045 (1)	0.15	(0.045) (1)

(1) These figures reflect the net profit from zinc recovery in rayon and acrylics. Recovery assumed at all production sites.

Source: Foster D. Snell, Inc. analysis of industry interviews and literature data.

SIC 282	T/D Level[1] / Technology	I	II	III 1	III 2
Value Of Industry Shipments (million dollars)					
9,796.9		0.14%	0.045%[2]	0.015%	0.045%[2]

(1) Assumes that each production facility is operating at their respective levels of full production.

(2) These figures reflect the net profit from zinc recovery in rayon and acrylic fiber production. It is assumed at all production sites.

Source: Foster D. Snell, Inc.

The summary of the relationships presented in Tables I- 3 and I- 4 are illustrative and are not necessarily representative. They would be substantially affected by shifts in the relative importance of the various products manufactured in each segment of the industry.

However, based on the assumptions of a static product mix, the percent of production value allocated to treatment and disposal of potentially hazardous wastes generated by this industry is relatively insignificant and is estimated at 0.15% or less.

Table I- 5 presents a synopsis of the findings concerning the potentially hazardous waste streams, their nature, amounts generated annually, the treatment and disposal technologies and associated costs on a product-by-product basis.

Table I-5

SYNOPSIS OF THE FINDINGS ON TREATMENT/DISPOSAL METHODS AND COSTS FOR THE PLASTIC MATERIALS AND SYNTHETICS INDUSTRY--SIC 282

SIC Code	Product	Waste Stream	Quantity of Potentially Hazardous Waste Generated (KKg/yr.)	Technology	T/D Level (1)	Costs (2) Product ($/KKg)	Costs (2) Per Plant ($/yr.)
2821	Phenolic Resins	Liquid fraction from reactor condensate	325,000	Incineration	I & II	16.3	224,000
		Solid sediments from reactor condensate	36,000	Storage	I	1.0	15,000
				Incineration with other materials	II-III	2.59	38,850
2822	Styrene, Butadiene Rubber	Still bottoms from monomer and solvent recovery	12,700	Incineration	I-II-III	0.22	13,000
2821	Polystyrene	Still bottoms	18,440	Incineration	I-II-III	0.30	17,000
2821	ABS-SAN	Still bottoms	2,700	Incineration	I-II-III	0.13	17,000
2821 2824	Polypropylene	Still bottoms	22,000	Incineration	I-II-III	0.22	21,000
2823	Rayon	Zinc containing sludge	7,200	Secured landfill	I-III-1	0.80	48,000
				Recovery	I-III-2	(11.7) (3)	406,400 (700,000) (4)
2824	Acrylics	Zinc containing sludge	278,000	Secured landfill	I-III-1	0.89	115,200
				Recovery	II-III-2	(4.75) (3)	603,000 (1,220,000) (4)

T/D = Treatment/Disposal

(1) See Tables II-55 through II-58, II-62, II-66 and II-69 for complete definitions of the respective T/D levels.

(2) This is the cost for a "typical" plant, at about the average production capacity for the particular product.

(3) This represents a net profit from the value of the recovered zinc.

(4) This represents the value of the recovered zinc at the typical plant.

Source: Summation of the information presented in Tables II-55 through II-62, II-66 and II-69

3.2 Summary Of The Rubber Products Industry, SIC 30

This section briefly summarizes industry structure, manufacturing processes, total and potentially hazardous wastes generated, and treatment and disposal technologies and associated costs for potentially hazardous wastes identified for SIC 30. A detailed discussion of these topics is presented in Chapter III of this report.

3.2.1 Industry Characterization

Table I-6 presents the number of plants, products produced, average size of plant, total industry production and employment for those establishments classified in SIC 30 based on information developed by the study team. The information presented in this table can be summarized as follows:

- SIC 3011 has approximately 206 plants, a total production volume for 1974 in excess of 3,424 KKKg (1,000 metric tons) and a total employment of 107,500
- SIC 3021 has approximately 44 plants, a total production for 1974 of 81 KKKg (1,000 metric tons) and employed 86,600 individuals
- SIC 3031 has only 9 plants, produced 135 KKKg (1,000 metric tons) of reclaimed rubber and employed only 800 workers
- SIC 3041 has 87 plants, produced 370 KKKg (1,000 metric tons) of product and employed 38,200 workers
- SIC 3069 had approximately 1,100 plants, produced 890 KKKg (1,000 metric tons) of product and employed about 100,000 workers.

The plants classified in SIC 30 are generally widely dispersed throughout the country with concentrations in the Northeastern states such as Massachusetts, Connecticut and New York and also in Ohio; EPA Regions I, II and V.

An alphabetical listing of plants classified in SIC 30 is contained in the EPA, OSWMP, Hazardous Waste Management Division files.

TABLE I-6

GENERAL CHARACTERIZATION OF THE
RUBBER PRODUCTS INDUSTRY, SIC 30

Code	Typical (1) Product	Number (2) of Plants	Typical (1) Plant Production (KKg/yr)	1974 Total (2) Industry Production (KKKg/yr)	Employment (2) (1000)
3011	Tires	206	59,400	3,424	107.5
3021	Canvas rubber	44	1,700	81	36.6
3031	Reclaimed rubber	9	2,500	135	.8
3041	Reinforced rubber hose	87	2,000	370	38.2
3069	Dry processed miscelleneous rubber products	1,102	900	890	99.5
	Totals	1,448	X	4,900	282.6

X not applicable
(1) Typical plant production corresponds to the typical product produced.
(2) These values are for the entire industry segments not just for the typical plant.

Source: Foster D. Snell cumulation of data presented in various tables in Chapter III.

3.2.2 Waste Characterization

In general, the processing operations of the rubber products industry are based on mechanical and dry processing techniques. The exceptions are the comparatively insignificant production found in rubber reclaiming and the wet processing of rubber goods.

Typical rubber processing involves: molding, extruding, sheeting, foaming, coating, fabrication of sections and vulcanization. The initial manufacturing operations involve batch treatment of the stock to incorporate colorants, extenders, reinforcers and special additives such as accelerators and antioxidants. After the batching step, the production operations can be continuous, semi-continuous or batch-continuous.

In general, the eight major steps or operations for the production of rubber products are:

- Raw materials receiving
- Raw materials storing
- Compounding
- Mixing
- Forming
- Curing
- Finishing and inspection
- Shipping

3.2.2.1 Potentially Hazardous And Non-Hazardous Wastes

The unit operations listed above generate the following wastes:

- Floor sweepings, consisting of material from broken bags, fiber packs, etc. and spillages in receiving, storage, compounding and milling areas

- Dusts and powders from the bag houses of dust collection equipment operating in the compounding and mixing areas

- Dusts and powders generated from general plant maintenance and equipment cleanout

- Oils used to lubricate the seals of mixing equipment contaminated with "oozings" containing process chemicals from the material being mixed

- Cured and uncured rubber

3.2.2.2 Criteria For The Determination Of Which Wastes Are Potentially Hazardous

Wastes classified as potentially hazardous are those arising from such unit operations as receiving, storing, compounding and mixing. These wastes are so classified because they are likely to contain known toxic or possibly carcinogenic substances in an unbound and unreacted state which may consist of such materials as pigments, antioxidants, accelerators, promotors, etc.

The seal oils from mixing equipment are likewise contaminated with processing chemicals and are therefore also classified as being potentially hazardous.

Wastes in which the potentially hazardous materials are either absent or have been compounded into the highly insoluble rubber matrix are strongly bound or reacted and therefore do not constitute a potential hazard. These wastes include:

- Cured and uncured rubber

- General plant trash such as pallets, packaging materials, etc.

Such wastes constitute 90% of the materials to be disposed of by the industry.

3.2.2.3 Methodology Used In Sampling And Analyzing The Various Waste Streams

Sampling of waste streams was used to spot check for the presence and concentrations of suspect compounds. The information obtained from the sampling program does not represent samples from the total industry studied. Samples were obtained of a wide variety of wastes from cooperating establishments in each of the SIC 30 industry segments under the supervision of Snell team members. Due to the randomness of wastes generated in this industry, truly representative samples were not obtained.

The results do point to the wide variability of physical and chemical properties of the samples studied. They support the findings from the visits and interviews that the chemicals which make the wastes potentially hazardous find their way into the materials to be discarded in a completely random manner.

The tests performed on the samples are as follows:

- Water extraction -- designed to determine qualitatively the water soluble fraction of the samples
- Water content of liquid sample -- designed to aid in the calculation of the wet versus dry basis of waste loads to be disposed
- Flammability of liquid samples
- Ash residue -- provides a measure of the percent of total inorganic content of the sample
- Emission spectroscopy -- provides a semi-quantitative value for the concentration of metals in the sample by type

- Atomic absorption spectroscopy -- performed selectively to provide quantitative values for the concentration of particular metals identified by emission spectroscopy and those which cannot be, e.g. mercury, cadmium and lead

Detailed methodology and test results are discussed in Appendix B.

3.2.2.4 Identification Of Those Hazardous Constituents Found In Waste Streams

Examples of hazardous constituents found in SIC 30 waste streams include:

- Diamines
- Phenylamines
- Benzothiazyl disulfide
- Dithiocarbamates

These chemicals are regarded [1] as toxic or possibly carcinogenic agents.

As discussed above, the potentially hazardous wastes resulting from manufacturing in this industry generally appear as a result of spillages from bulk material handling, accidental rupture of bags and fiber packs, the collection of dusts from particulate control apparatus and "oozings" of oil contaminated with raw materials from mixing equipment seals.

It is impossible to predict with any degree of confidence which bags will break on a particular occasion at a plant. In any given time period, a container of an antioxidant such as phenylenediamine, an agent suspected of causing bladder tumors in humans, may rupture. For that time period, floor sweepings may contain significant amounts of the suspect carcinogen.

(1) Dangerous Properties of Industrial Materials (4th Ed.) N. Irving Sax, Van Nostrand Reinhold Company, New York, 1974.

On the other hand, during the next time period, only a container of titanium dioxide, an innocuous substance, may rupture, producing floor sweepings which are not considered to be potentially hazardous.

Due to the chance occurrence of the breakage of particular containers, it is not possible to predict what precise potentially hazardous component, if any, a waste may contain during any given time period. Likewise, concentrations of the potentially hazardous components are not possible to arrive at with any degree of confidence.

3.2.2.5 Waste Quantification For SIC 30 For 1974, 1977 And 1983

In Table I-7 the waste quantification for the years of interest as a summary for the entire SIC 30 is presented. The information is presented in terms of total wastes and potentially hazardous wastes. There are insignificant amounts of water present in the waste materials, therefore total and potentially hazardous waste quantities are presented on a dry basis only. Potentially hazardous wastes are not broken down into their constituents due to the randomness of their appearance and concentrations. Finally, based on information obtained from interviews performed of industry personnel, no significant increase in waste loads are expected due to the estimated effects of the 1977 and 1983 Water Effluent Limitation Guidelines Regulations.

From the table it can be seen that total and potentially hazardous waste loads on a national basis, are as follows:

	Wastes (Dry or Wet Basis)	
	Total (KKg/yr)	Potentially Hazardous (KKg/yr)
1974	502,795	48,479
1977	548,324	52,212
1983	568,983	54,122

Source: Foster D. Snell, Inc.

TABLE I-7

TOTAL ESTIMATED GEOGRAPHIC DISTRIBUTION OF WASTES (1), RUBBER PRODUCTS INDUSTRY. SIC 30 (DRY OR WET BASIS) (2)

(KKg/yr)

		1974		1977		1983	
		Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes	Total Wastes	Potentially Hazardous Wastes
IV	Alabama	21685	2882	22957	3046	23750	3150
X	Alaska						
IX	Arizona	563	40	628	45	653	46
VI	Arkansas	6728	782	7204	830	7462	866
IX	California	35148	3677	38099	3949	39515	4093
VIII	Colorado	6956	511	7756	569	8070	594
I	Connecticut	10006	838	10983	910	11406	945
III	Delaware	3523	204	3929	227	4087	238
IV	Florida	2466	175	2749	195	2861	203
IV	Georgia	9795	778	10702	838	11109	869
IX	Hawaii						
X	Idaho						
V	Illinois	18419	1789	20071	1930	20830	2001
V	Indiana	35465	2756	39299	3039	40856	3159
VII	Iowa	11147	1395	11887	1481	12306	1532
VII	Kansas	6903	919	7309	972	7561	1005
IV	Kentucky	6775	812	7257	864	7518	895
VI	Louisiana						
I	Maine	2350	22	2620	25	2726	25
III	Maryland	7033	700	7577	744	7853	775
I	Massachusetts	34317	2163	37888	2360	39378	2449
V	Michigan	25642	3045	27479	3243	28465	3356
V	Minnesota	3246	232	3619	259	3766	269
IV	Mississippi	8813	1012	9477	1080	9821	1119
VII	Missouri	4536	329	5057	368	5262	382
VIII	Montana						
VII	Nebraska	2316	168	2582	188	2687	194
IX	Nevada						
I	New Hampshire	1702	64	1897	72	1974	73
II	New Jersey	8180	531	9121	591	9489	615
VI	New Mexico						
II	New York	12365	1051	13579	1144	14107	1185
IV	North Carolina	15249	1239	16640	1332	17274	1380
VIII	North Dakota						
V	Ohio	93007	8880	102774	9620	106697	9979
VI	Oklahoma	10309	1315	10965	1394	11348	1441
X	Oregon	1233	87	1375	97	1430	101
III	Pennsylvania	23897	2600	25722	2772	26658	2869
I	Rhode Island	4015	203	4477	226	4658	235
IV	South Carolina	9353	1084	10040	1156	10405	1196
VIII	South Dakota	107	8	119	9	124	9
IV	Tennessee	29148	3172	31493	3399	32652	3520
VI	Texas	12438	1325	13468	1422	13968	1473
VIII	Utah	767	56	855	62	890	65
I	Vermont	961	16	1071	18	1115	18
III	Virginia	3537	367	3830	393	3972	408
X	Washington	574	41	641	46	666	47
III	West Virginia	1327	67	1480	74	1539	78
V	Wisconsin	10794	1144	11648	1223	12075	1265
VIII	Wyoming						
	TOTAL	502795	48479	548324	52212	568983	54122
	Region I	53351	3306	58936	3611	61257	3745
	II	20545	1582	22700	1735	23596	1800
	III	39317	3938	42538	4210	44109	4368
	IV	103284	11154	111315	11910	115387	12332
	V	186573	17845	204890	19314	212691	20029
	VI	29475	3422	31637	3646	32779	3780
	VII	24902	2812	26835	3009	27816	3113
	VIII	7830	575	8730	640	9084	668
	IX	35711	3717	38727	3994	40168	4139
	X	1807	128	2016	143	2096	148

(1) Excludes SIC 3031, whose wastes are insignificant in a weight basis.

(2) Solid Wastes from SIC 30 are essentially all dry and contain under 1% water on a weight basis.

Tables within Chapter III present the above information for each four digit SIC within the rubber products industry.

Figure I-4, pictorially presents the estimated geographic distribution of total wastes (dry basis). Figure I-5, does the same for potentially hazardous wastes (dry basis) for the year 1974. The estimated geographic distribution of wastes will not change for 1977 and 1983 in relation to 1974.

Generally, the greatest total and potentially hazardous waste loads are distributed among the states in EPA Regions IV and V reflecting the heavy concentrations of SIC 30 establishments in these regions.

3.2.3 Treatment And Disposal Technology

This section briefly reviews the various treatment and disposal technologies practiced by the rubber products industry and identifies the three technology levels for those waste streams considered potentially hazardous.

3.2.3.1 Present Potentially Hazardous Waste Treatment And Disposal Practices

Land destined potentially hazardous wastes from this industry originate incidentally from the manufacturing processes; that is, from housekeeping practices, or from air pollution control systems. The potentially hazardous wastes from all segments of SIC 30, exclusive of SIC 3031, Rubber Reclaiming, are in general very similar. They are predominantly fine powders composed of the raw materials consumed by this industry in the free or unbound state. The small quantity of potentially hazardous wastes generated by SIC 3031 are contaminated devulcanizing agents in the form of liquids.

The potentially hazardous wastes generated by SIC 30 are generally restricted to landfill for disposal. Recovery of these materials is not possible, in most cases, due to the randomness of the concentrations of their constituents. In general, these landfills are of the general purpose type, that is, they are not impervious to water and do not have monitoring for leachate and are therefore not adequate for the disposal of these types of wastes due to possible leaching into the water table.

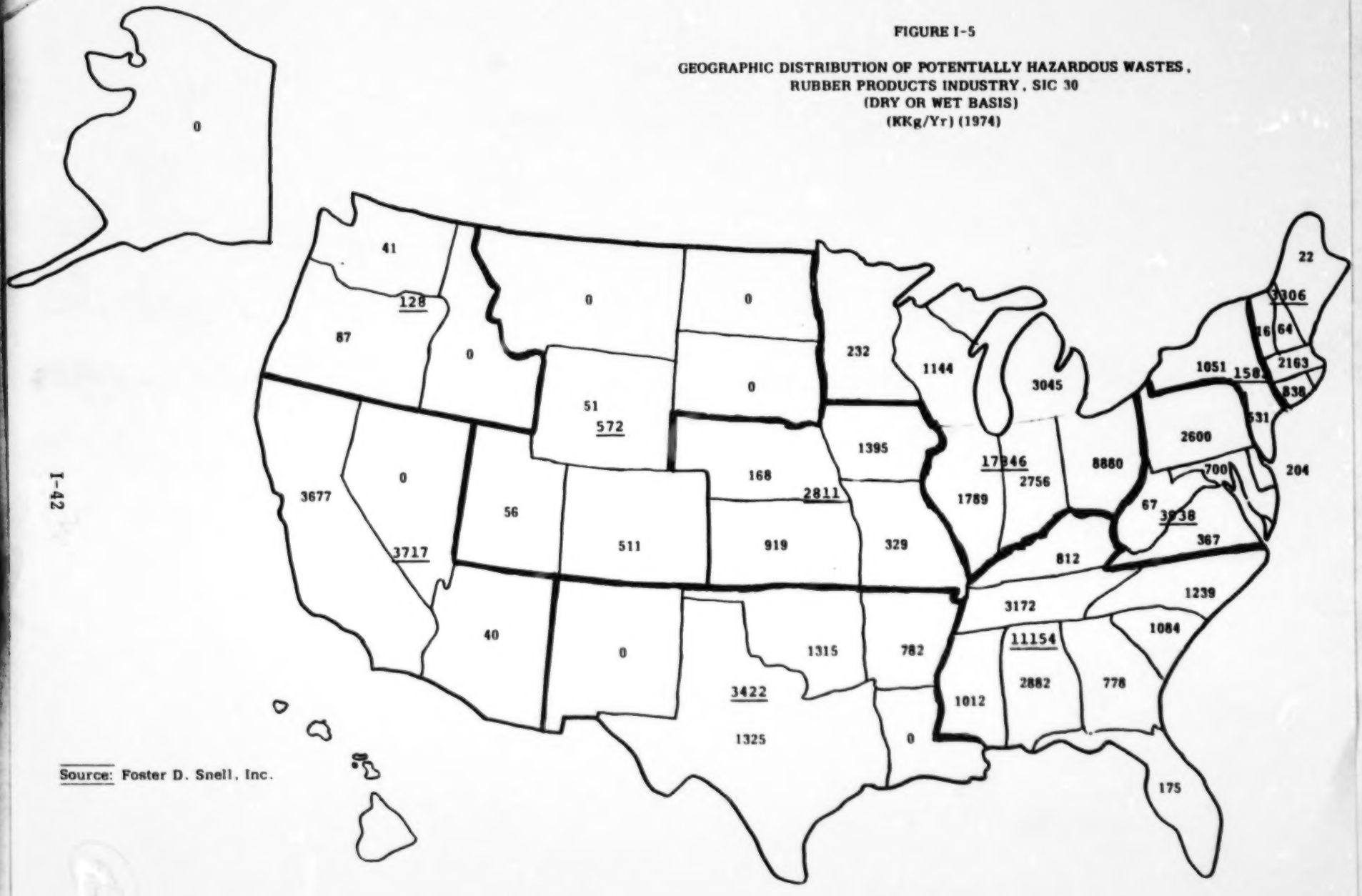
FIGURE I-4

GEOGRAPHIC DISTRIBUTION OF TOTAL WASTES,
RUBBER PRODUCTS INDUSTRY, SIC 30
(DRY OR WET BASIS)
(KKg/Yr) (1974)

Source: Foster D. Snell, Inc.

FIGURE I-5

GEOGRAPHIC DISTRIBUTION OF POTENTIALLY HAZARDOUS WASTES,
RUBBER PRODUCTS INDUSTRY, SIC 30
(DRY OR WET BASIS)
(KKg/Yr) (1974)



Source: Foster D. Snell, Inc.

Waste oils contaminated with raw materials used in rubber products manufacturing from the mixing equipment are generally stored on land in steel drums at a remote corner of the plant.

On the surface the present "store it and forget it" practice would appear grossly inadequate. The oils, however, will set up or vulcanize after about 1 to 2 years. It is recalled that the vulcanization process has been considered in effect a chemical detoxification of the mixture of raw materials used in rubber products operations, then the oils once vulcanized can be considered to have lost their potentially hazardous character. These oily wastes may then be disposed in a general purpose landfill without further precaution.

Aside from the waste devulcanizing agents or oils from SIC 3031 to be discussed next, the only other potentially hazardous waste stream identified in this industry are the wastes from the production of lead cured hose in SIC 3041. These wastes are present in three forms and are disposed as follows:

- Pure lead scrap -- recycled at the plant
- Lead dross (lead oxide) -- sold to reclaimers for lead recovery
- Lead salts in sludges from wastewater treatment -- In most cases plants do not pretreat their lead laden wastewaters but send these streams to municipal sewage treatment facilities. One hose plant visited had on-site water treatment. Lead bearing sludges were placed in a general purpose landfill in sealed and labelled polyethylene bags.

Waste devulcanizing agents from the rubber reclaiming industry are reused in most cases. In one instance they were reprocessed for a fee by a waste oil reclaimer.

Table I-8 summarizes the potentially hazardous wastes from SIC 30.

TABLE I-8

SUMMARY OF TYPICAL PLANT POTENTIALLY HAZARDOUS WASTES FROM RUBBER PRODUCTS MANUFACTURE, SIC 30

SIC	Industry	1974 Total Industry Production (KKKg/yr)	Typical Product Produced	Typical Plant Production (KKg/yr)		Significant Potentially Hazardous Waste Stream	Potentially Hazardous Typical Plant Waste Stream (Dry Basis) (KKg/yr)	Size of Typical Plant Total Waste Stream (Dry Basis) (KKg/yr)
3011	Tire and Inner Tube	3,424	Tires	59,400	(1)	Floor sweepings (receiving, warehousing and compounding areas)	113	4,241
					(2)	Dust from compounding and mixing collected by pollution control equipment	493	
					(3)	Oily wastes	29	
3021	Rubber and Plastics Footwear Industry	81	Canvas rubber footwear	1,700	(1)	Floor sweepings (receiving, warehousing and compounding areas)	1.6	907
					(2)	Dust from compounding and mixing collected by pollution control equipment	6.9	
					(3)	Oily wastes	Negligible	
3031	Rubber Reclaiming		Reclaimed rubber	2,500	(1)	Oils contaminated with devulcanizing agents	30	720
3041	Rubber and Plastics Hose and Belting	370	Reinforced rubber hose	2,000	(1)	Floor sweepings (receiving, warehousing and compounding areas)	3.5	258
					(2)	Dust from compounding and mixing collected by pollution control equipment	15.5	
					(3)	Oily wastes	Negligible	
					(4)	Lead wastes		
3069	Rubber Products Industry, N.E.C.	890	Dry processed mixcellaneous rubber products	900	(1)	Floor sweepings (receiving, warehousing and compounding areas)	2.7	241
					(2)	Dust from compounding and mixing collected by pollution control equipment	11.7	
					(3)	Oily wastes	Negligible	

Source: Foster D. Snell analysis of literature and industry interviews

3.2.3.2 Identification Of The Three Levels Of Treatment And Disposal Technology For Those Streams Considered To Be Potentially Hazardous

The levels of treatment and disposal technology are characterized as follows:

- Level I -- Technology Currently Employed By Typical Facilities
- Level II -- Best Technology Currently Employed
- Level III -- Technology Necessary To Provide Adequate Health And Environmental Protection

These levels were evaluated for the potentially hazardous wastes generated by SIC 30 by the use of ten factors as listed previously on page I-24.

The three levels of treatment and disposal technology are described for each of the five, four digit SICs that comprise the rubber products industry in a series of tables in Chapter III.

The data indicates that the prevalent treatment and disposal practice for SIC 30 potentially hazardous wastes is the almost universal use of general purpose landfills as shown in Table I-9. Environmentally adequate disposal would be achieved by using secured landfills, that is, those where the following safeguards are in effect:

- Disclosure by the landfill user of the composition and volume of each hazardous waste and approval by pertinent regulatory agencies
- The site is geologically and hydrologically approved for the hazardous waste
- Monitoring wells are provided
- If required, leachate control and treatment is provided
- Records of burial coordinates are kept to avoid any chemical interactions.

3.2.4 Cost Analysis For The Treatment And Disposal Of Potentially Hazardous Wastes, Rubber Products Industry

The basis for the cost analysis presented here is the average values developed from the industry interviews. Since the methods used in SIC 30 for waste disposal do not involve chemical engineering nor any other significant form of capital investment, with the exception of the hypothetical upgrading of landfill sites, this analysis is straightforward.

The factors involved are:

- Volume of wastes
- Contracting fees for disposal
- Long distance haulage, if required
- Cost of containing material
- Capital costs for upgrading a presently used landfill
- Labor costs at the plant

3.2.4.1 Typical Cases Of Potentially Hazardous Waste Disposal Costs

Based on the cost elements presented above, the individual costs for a typical plant in each of the industry groupings have been calculated.

The individual cases are presented in tables in Chapter III for SICs 3011, 3021, 3041 and 3069. It is to be noted that no cost analysis has been presented for SIC 3031, Rubber Reclaiming. The reason for the omission is that less than 135 KKg/yr potentially hazardous waste has been identified for this industry to be land disposed. Similarly, the volumes of hazardous wastes generated by such processes as the wet processes in SIC 3069 and plastic hose in SIC 3041 are less than 300 KKg/yr and therefore too small to warrant specific discussion.

3.2.4.2 Extrapolation Of Technology Costs To The Entire Rubber Products Industry

Yearly expenditures for potentially hazardous wastes disposal are presented in Table I-9. These costs are summarized for SIC 30 as follows:

TABLE I-9

YEARLY EXPENDITURES FOR POTENTIALLY HAZARDOUS WASTE DISPOSAL IN THE RUBBER PRODUCTS INDUSTRY, SIC 30

Dollars (1974)

SIC Code	Production (KKKg/yr)	Potentially Hazardous Waste (KKg/yr)	T/D Level I	II	III			
			Technology		1	2	3	4
3011	3,424	30,700	1,780,000	1,780,000	1,780,000	1,960,000	2,150,000	2,700,000
3021	81	390	13,000	13,000	13,000	-	-	25,000
3041	370	3,000	99,000	99,000	99,000	-	-	192,000
3069	890	10,000	353,000	353,000	353,000	-	-	663,000

Treatment/Disposal Technology

Level I	Unsecured municipal landfill, offsite.
Level II	Same as Level I, but the municipal landfill is secured.
Level III-1	Same as Level II
Level III-2	Ship 150 Km to a secured landfill
Level III-3	Upgrading a portion of an existing landfill to secured status with 10 year capacity
Level III-4	Simple municipal landfill. Offsite but the material is disposed of in polyethylene lined steel drums.

Source: Foster D. Snell, Inc.

3.2.4.3 Comparison Of Technology Costs With Production Value For The Entire Rubber Products Industry

Table I-10 presents the percent of production value allocated to treatment and disposal of potentially hazardous wastes. These relationships are summarized as follows for SIC 30.

		Percent			
	T/D Level	I	II	III[1]	
SIC 30	Technology			1	4
Value of Industry Shipments (million dollars)					
10,227.8		0.022%[2]	0.022%[2]	0.022%	0.035%

(1) Levels III-2 and III-3 are not included because they are not representative for the entire industry.

(2) Based on interview results, no cost difference was found, on the average, between unsecured and secured municipal landfills.

Level I	Unsecured municipal landfill, offsite.
Level II	Same as Level I, but the municipal landfill is secured
Level III-1	Same as Level II
Level III-2	Ship 150 Km to a secured landfill
Level III-3	Upgrading a portion of an existing landfill to secured status with 10 year capacity
Level III-4	Simple municipal landfill. Offsite but the material is disposed of in polyethylene lined steel drums.

Source: Foster D. Snell, Inc.

From the above table it can been seen that, the percent of production value allocated to treatment and disposal of potentially hazardous wastes generated by this industry is insignificant and is estimated to be 0.035% or less.

Table I-11 presents a synopsis of findings on treatment and disposal technologies and associated costs on a product-by-product basis.

TABLE I-10

PERCENT OF PRODUCTION VALUE ALLOCATED TO TREATMENT AND DISPOSAL OF POTENTIALLY HAZARDOUS WASTES IN THE RUBBER PRODUCTS INDUSTRY, SIC 30

SIC Code	T/D Level Technology	Percent of Production Value I	II	III 1	2	3	4
3011		0.032	0.032	0.032	0.040	0.044	0.055
3021		0.0026	0.0026	0.0026	N.A.	N.A.	0.0052
3041		0.011	0.011	0.011	N.A.	N.A.	0.022
3069		0.014	0.014	0.014	N.A.	N.A.	0.028

N.A.= Not Applicable

Treatment/Disposal Technology

Level I	Simple municipal landfill, off-site
Level II	Same as Level I, but municipal landfill is secured
Level III	1. Same as Level II
Level III	2. Ship 150 Km to a secure landfill
Level III	3. Upgrading a portion of existing landfill to secured status with 10 year capacity
Level III	4. Simple municipal landfill, off-site, with the material disposed of in polyethylene lined steel drums.

Source: Foster D. Snell, Inc. analysis of industry interviews and literature data.

TABLE I-11

SYNOPSIS OF FINDINGS ON POTENTIALLY HAZARDOUS WASTE TREATMENT/DISPOSAL METHODS AND COSTS FOR RUBBER PRODUCTS INDUSTRY, SIC 30 (1974)

SIC Code	Typical Product	Potentially Hazardous Waste	Total Estimated Potentially Hazardous Waste Produced (KKg/Yr)	Technology	T/D Level	Costs (1) $/KKg Product	Costs (1) Per Plant $/Year
3011	Tires	Floor sweepings and dust from air pollution control equipment	30,700	. Disposal in unsecured municipal landfill, off-site	I	0.62	36,900
				. Disposal in secured municipal landfill, off-site	II	0.62	36,900
				. Same as Level II	III (1)	0.62	36,900
				. Ship 150 km to secured landfill	III (2)	0.69	40,700
				. Upgrading portion of existing unsecured landfill to secured status with 10 year capacity	III (3)	0.75	44,600
				. Material disposed of in polyethylene lined steel drums in unsecured municipal landfill, off-site	III (4)	0.94	56,100
3021	Canvas and Rubber Footwear	Floor sweepings and dust from air pollution control equipment	390	. Disposal in unsecured municipal landfill, off-site	I	0.16	275
				. Disposal in secured municipal landfill, off-site	II	0.16	275
				. Material disposed of in polyethylene lined steel drums in unsecured municipal landfill, off-site	III	0.31	525
3041	Reinforced Rubber Hose	Floor sweepings and dust from air pollution control equipment	3,000	. Disposal in unsecured municipal landfill, off-site	I	0.28	550
				. Disposal in secured municipal landfill, off-site	II	0.28	550
				. Material disposed of in polyethylene lined steel drums in unsecured municipal landfill, off-site	III	0.53	1,050
3069	Miscellaneous Rubber Products	Floor sweepings and dust from air pollution control equipment	10,000	. Disposal in unsecured municipal landfill, off-site	I	0.40	360
				. Disposal in secured municipal landfill, off-site	II	0.40	360
				. Material disposed of in polyethylene lined steel drums in unsecured municipal landfill, off-site.	III	0.73	660

T/D = Treatment/Disposal

(1) Costs for a "typical plant" operating at average production capacity for the particular product.

Source: Foster D. Snell, Inc.

	Dollars (1974)			
T/D Level	I	II	III[1]	
Technology			1	4
SIC 30	2,245,000[2]	2,245,000[2]	2,245,000	3,580 000

(1) Levels III-2 and III-3 are not included because they are not representative for the entire industry.

(2) Based on interview results, no cost difference was found, on the average, between unsecured and secured municipal landfills.

Treatment/Disposal Technology

Level I	Unsecured municipal landfill, offsite
Level II	Same as Level I, but the municipal landfill is secured
Level III-1	Same as Level II
Level III-2	Ship 150 Km to a secured landfill
Level III-3	Upgrading a portion of an existing landfill to secured status with 10 year capacity
Level III-4	Simple municipal landfill. Offsite but the material is disposed of in polyethylene lined steel drums.

Source: Foster D. Snell Inc.

The disposal technologies used by all segments of SIC 30 are similar, and therefore the levels are not discussed separately for each segment but rather on an industry-wide basis.

There is no cost difference between Level I and Level II. For Level III, it should be noted that three alternative technologies are envisioned for SIC 3011 only. The reason for this is that the plants of the other segments do not have the volume to justify these technologies. For instance long distance hauling cannot be contemplated for loads of less than, say 15,000 Kg (33,000 lbs). It is to be noted that it would take almost two years for a canvas rubber footwear plant to accumulate this volume. The same consideration applies to the upgrading of a landfill site. For instance, the volume of potentially hazardous waste generated by a typical reinforced rubber hose plant is 33 cu. m.(40 cu.yd) per year. This is less than the volume of clay necessary to provide the required barrier for this amount of material. On the other hand, it should be noted that the cost of drumming the waste for a tire plant is the most expensive solution for this type of operation.

* * *

This chapter provided a summary of our findings and conclusions regarding the assessment of industrial hazardous waste practices for the rubber and plastics industry. The following chapter discusses in-detail information on the plastic materials and synthetics industry, SIC 282. The last chapter does the same for the rubber products industry.

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